

Appln No. 10/075,473
Amdt date September 3, 2004
Reply to Office action of June 3, 2004

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1. (Currently Amended) A method for preparing a positive active material for a rechargeable lithium battery comprising:

mixing a lithium source, a metal source, and a doping liquid comprising a doping element to form a mixture; and

heat-treating the mixture, the heat-treating step comprising:

a first heat-treatment at a temperature ranging from about 400°C to about 500°C;
and

a second heat-treatment at a temperature ranging from about 700°C to about
900°C.

2. (Original) The method according to claim 1, wherein the doping element is selected from the group consisting of Mg, Al, Co, K, Na, Ca, Si, Ti, Sn, V, Ge, Ga, B, As, Zr, Ni, Mn, Cr, Sr, rare earth metals, and mixtures thereof.

3. (Original) The method according to claim 1, wherein the doping liquid comprises a volatile solvent or water.

4. (Original) The method according to claim 1, wherein the doping liquid comprises alcohol.

5. (Original) The method according to claim 1, wherein the metal source is at least one compound selected from the group consisting of manganese sources, nickel sources, and cobalt sources.

6. (Original) The method according to claim 1, wherein the positive active material is selected from the group consisting of compounds represented by the formulas 1 to 13:

- | | |
|---|------|
| $\text{Li}_x\text{Mn}_{1-y}\text{M}_y\text{A}_2$ | (1) |
| $\text{Li}_x\text{Mn}_{1-y}\text{M}_y\text{O}_{2-z}\text{X}_z$ | (2) |
| $\text{Li}_x\text{Mn}_2\text{O}_{4-z}\text{X}_z$ | (3) |
| $\text{Li}_x\text{Mn}_{2-y}\text{M}_y\text{A}_4$ | (4) |
| $\text{Li}_x\text{Co}_{1-y}\text{M}_y\text{A}_2$ | (5) |
| $\text{Li}_x\text{Co}_{1-y}\text{M}_y\text{O}_{2-z}\text{X}_z$ | (6) |
| $\text{Li}_x\text{Ni}_{1-y}\text{M}_y\text{A}_2$ | (7) |
| $\text{Li}_x\text{Ni}_{1-y}\text{M}_y\text{O}_{2-z}\text{X}_z$ | (8) |
| $\text{Li}_x\text{Ni}_{1-y}\text{Co}_y\text{O}_{2-z}\text{X}_z$ | (9) |
| $\text{Li}_x\text{Ni}_{1-y-z}\text{Co}_y\text{M}_z\text{A}_\alpha$ | (10) |
| $\text{Li}_x\text{Ni}_{1-y-z}\text{Co}_y\text{M}_z\text{O}_{2-\alpha}\text{X}_\alpha$ | (11) |
| $\text{Li}_x\text{Ni}_{1-y-z}\text{Mn}_y\text{M}_z\text{A}_\alpha$ | (12) |
| $\text{Li}_x\text{Ni}_{1-y-z}\text{Mn}_y\text{M}_z\text{O}_{2-\alpha}\text{X}_\alpha$ | (13) |

wherein

$0.95 \leq x \leq 1.1$, $0 \leq y \leq 0.5$, $0 \leq z \leq 0.5$, $0 < \alpha \leq 2$;

M is selected from the group consisting of Mg, Al, Co, K, Na, Ca, Si, Ti, Sn, V, Ge, Ga, B, As, Zr, Ni, Mn, Cr, Sr, rare earth metals, and mixtures thereof;

A is selected from the group consisting of O, F, S, and P; and

X is selected from the group consisting of F, S, and P.

7. (Cancel).

8. (Currently Amended) The method according to claim [7] 1, wherein the first ~~[heat treating step]~~ heat treatment is maintained for about 5 hours to about 20 hours; and the second ~~[heat treating step]~~ heat treatment is maintained for about 10 hours to about 30 hours.

9. (Cancel).

10. (Currently Amended) A method for preparing a positive active material for a rechargeable lithium battery comprising:

mixing a lithium source; at least one metal source including at least one of a cobalt source, a manganese source, and a nickel source; and a doping liquid comprising a doping element selected from the group consisting of Mg, Al, Co, K, Na, Ca, Si, Ti, Sn, V, Ge, Ga, B, As, Zr, Ni, Mn, Cr, Sr, rare earth metals, and mixtures thereof to form a mixture; and

heat-treating the mixture, the heat-treating step comprising:

a first heat treatment at a temperature ranging from about 400°C to about 500°C;
and

a second heat treatment at a temperature ranging from about 700°C to about
900°C.

11. (Original) The method according to claim 10, wherein the doping liquid comprises a volatile solvent or water.

12. (Original) The method according to claim 10, wherein the doping liquid comprises alcohol.

13. (Original) The method according to claim 10, wherein the positive active material is selected from the group consisting of compounds represented by the formulas 1 to 13:



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$\text{Li}_x\text{Co}_{1-y}\text{M}_y\text{O}_{2-z}\text{X}_z$ (6)
 $\text{Li}_x\text{Ni}_{1-y}\text{M}_y\text{A}_2$ (7)
 $\text{Li}_x\text{Ni}_{1-y}\text{M}_y\text{O}_{2-z}\text{X}_z$ (8)
 $\text{Li}_x\text{Ni}_{1-y}\text{Co}_y\text{O}_{2-z}\text{X}_z$ (9)
 $\text{Li}_x\text{Ni}_{1-y-z}\text{Co}_y\text{M}_z\text{A}_a$ (10)
 $\text{Li}_x\text{Ni}_{1-y-z}\text{Co}_y\text{M}_z\text{O}_{2-a}\text{X}_a$ (11)
 $\text{Li}_x\text{Ni}_{1-y-z}\text{Mn}_y\text{M}_z\text{A}_a$ (12)
 $\text{Li}_x\text{Ni}_{1-y-z}\text{Mn}_y\text{M}_z\text{O}_{2-a}\text{X}_a$ (13)

wherein

$0.95 \leq x \leq 1.1$, $0 \leq y \leq 0.5$, $0 \leq z \leq 0.5$, $0 < a \leq 2$;

M is selected from the group consisting of Mg, Al, Co, K, Na, Ca, Si, Ti, Sn, V, Ge, Ga, B, As, Zr, Ni, Mn, Cr, Sr, rare earth metals, and mixtures thereof;

A is selected from the group consisting of O, F, S, and P; and

X is selected from the group consisting of F, S, and P.

14. (Cancel).

15. (Currently Amended) The method according to claim [14] 10, wherein the first [heat treating step] heat treatment is maintained for about 5 hours to about 20 hours; and the second [heat treating step] heat treatment is maintained for about 10 hours to about 30 hours.

16. (Cancel).

17. (Currently Amended) A method for preparing a positive active material for a rechargeable lithium battery comprising:

mixing a lithium source; at least one metal source including at least one of a cobalt source, a manganese source, and a nickel source; and an Al-including doping liquid or a B-including doping liquid to form a mixture; and

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heat-treating the mixture, the heat-treating step comprising:

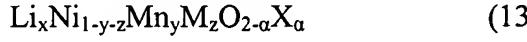
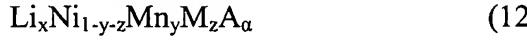
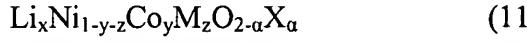
a first heat treatment at a temperature ranging from about 400°C to about 500°C;
and

a second heat treatment at a temperature ranging from about 700°C to about
900°C.

18. (Original) The method according to claim 17, wherein the doping liquid comprises a volatile solvent or water.

19. (Original) The method according to claim 17, wherein the doping liquid comprises alcohol.

20. (Original) The method according to claim 17, wherein the positive active material is selected from the group consisting of compounds represented by the formulas 1 to 13:



wherein - - - - -

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$0.95 \leq x \leq 1.1$, $0 \leq y \leq 0.5$, $0 \leq z \leq 0.5$, $0 < \alpha \leq 2$;

M is selected from the group consisting of Mg, Al, Co, K, Na, Ca, Si, Ti, Sn, V, Ge, Ga, B, As, Zr, Ni, Mn, Cr, Sr, rare earth metals, and mixtures thereof;

A is selected from the group consisting of O, F, S, and P; and

X is selected from the group consisting of F, S, and P.

21. (Cancel).

22. (Currently Amended) The method according to claim [24] 17, wherein the first [heat treating step] heat treatment is maintained for about 5 hours to about 20 hours; and the second [heat treating step] heat treatment is maintained for about 10 hours to about 30 hours.

23. (Cancel).

24. (Original) The method according to claim 17, wherein the metal source is a cobalt source, and the doping liquid is an Al-including doping liquid.

25. (Original) The method according to claim 17, wherein the metal source is a manganese source or a nickel source, and the doping liquid is an Al-including doping liquid.

26. (Original) The method according to claim 17, wherein the metal source is a manganese source or a nickel source, and the doping liquid is a B-including doping liquid.